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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 7/20

A1

(11) International Publication Number: WO 00/04732

(43) International Publication Date: 27 January 2000 (27.01.00)

(21) International Application Number: PCT/IL99/00389

(22) International Filing Date: 14 July 1999 (14.07.99)

(30) Priority Data:
09/116,051 15 July 1998 (15.07.98) US

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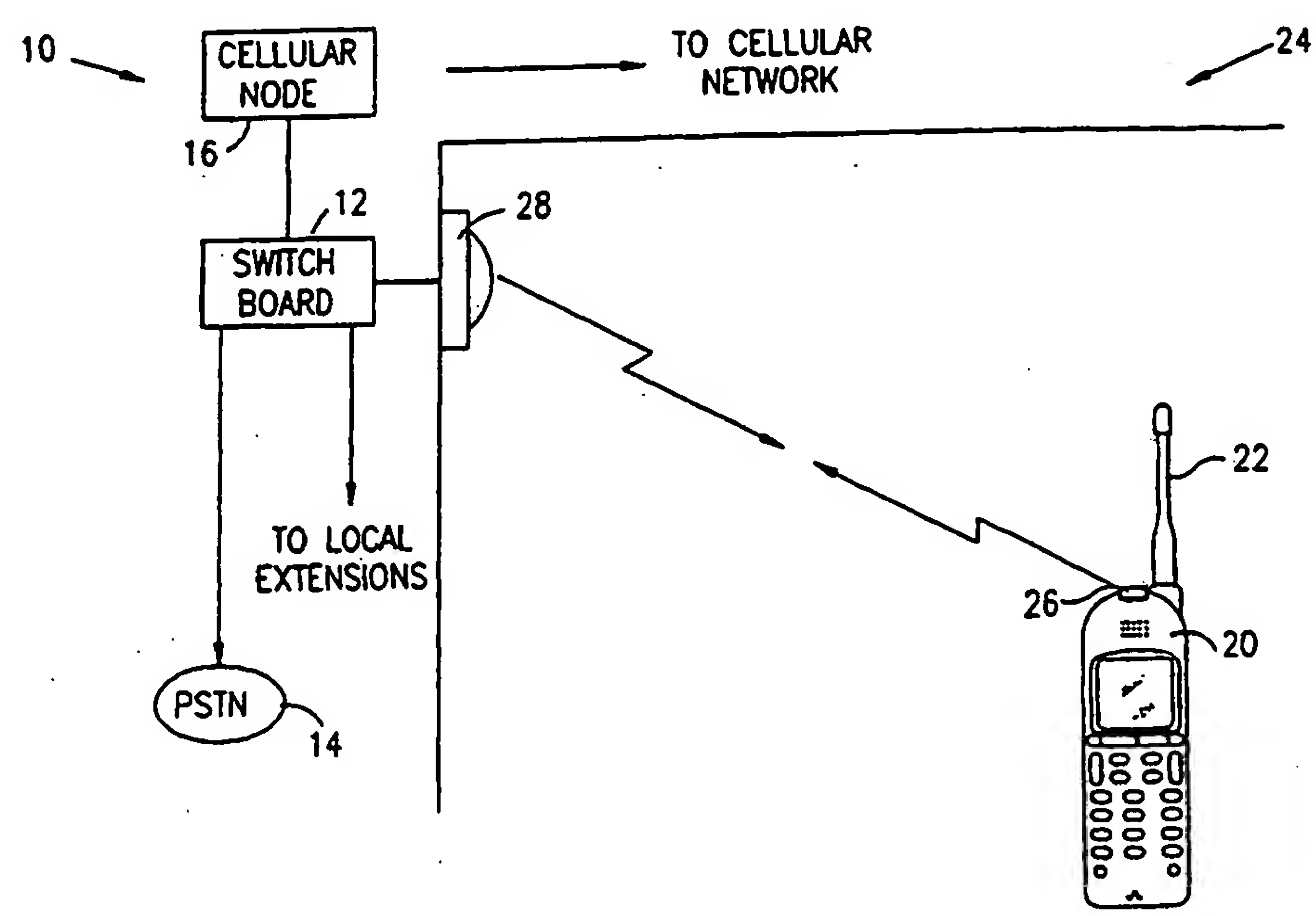
(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published**
*With international search report.*

(54) Title: CELLULAR PHONE WITH IR LINK




(57) Abstract

A local telephone network (10) includes a switchboard and at least one base station coupled to the switchboard and including an IR transmitter and receiver. A dual-mode wireless telephone (20) inlcudes an IR interface device, which communicates with the base station IR transmitter and receiver (28), and an RF interface device, which communicates with a cellular communications network.

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# CELLULAR PHONE WITH IR LINK

## FIELD OF THE INVENTION

The present invention relates generally to wireless communication devices, and specifically to infrared (IR) wireless telephones.

## BACKGROUND OF THE INVENTION

Wireless telephones, including both cellular telephones and cordless phones, generally communicate using RF transmission and reception. IR wireless phones are also known in the art, however. Such telephones typically provide for two-way diffuse IR transmission between a wired telephone line and a telephone handset.

For example, European patent application no. 558,812, which is incorporated herein by reference, describes a cordless telephone handset that is linked by a photodiode and LED to a fixed station having an IR transmitter and receiver, coupled to a conventional telephone line. The fixed station is placed on a desk or mounted on a wall, while the handset can be moved around within the room. The use of IR communications, in place of RF, reduces susceptibility to interference with and interception of communications and also reduces the exposure of users of the telephone to potentially harmful radiation

Sharp Corporation, of Japan, offers the "PMC" line of cellular telephones having an IR communication port. This port is designed for local, very short-range communication, with a personal computer, for example, enabling the cellular telephone to be used for data communication, typically in order to download information from the computer to an organizer embedded in the telephone. The telephone communicates with its cellular network exclusively by means of a conventional RF transmitter/receiver. The Nokia 9000 series of cellular telephones offers similar capabilities.

## SUMMARY OF THE INVENTION

It is an object of some aspects of the present invention to provide a cellular telephone that reduces the exposure of users thereof to RF radiation.

It is a further object of some aspects of the present invention to provide a cellular telephone having reduced susceptibility to interference with and interception of wireless transmissions.

It is still a further object of some aspects of the present invention to provide a telephone system for businesses and other enterprises offering improved convenience and reduced operating costs.

In preferred embodiments of the present invention, a cellular telephone comprises both RF and omni-directional IR communications interfaces. The IR interface communicates with suitable IR transmitter/receiver base stations, located within a building, typically an office, which stations are coupled to a local telephone network in the building. When the cellular telephone is inside the building, its location is registered by the local telephone network, and calls to and from the telephone are routed through the network, via IR link between the telephone and one of the base stations in proximity thereto. Preferably, the telephone is capable, through the local network, of placing calls to and receiving calls from other telephones in the building and other wired and cellular telephones outside the building. When the telephone leaves the building, it communicates via its RF communications interface, like a conventional cellular telephone, with transmission stations of a cellular telephone network.

There is therefore provided, in accordance with a preferred embodiment of the present invention, a dual-mode wireless telephone, including:

a RF interface, which communicates with a cellular communications network; and

an IR interface, which communicates with a local telephone network.

Preferably, the IR interface includes an omni-directional interface.

Preferably, the telephone includes a selector, which selects either the RF or the IR interface to be operational for conveying a telephone call between the interface and the respective network. Preferably, the IR interface detects an IR signal transmitted by an IR base station associated with the local telephone network, and the selector selects the IR interface responsive to the signal. Preferably, the selector selects the RF interface when the IR signal is not detected, and the IR interface detects the IR signal while the RF interface is selected.

There is also provided, in accordance with a preferred embodiment of the present invention, a local telephone network, including:

a switchboard;

at least one base station coupled to the switchboard and including an IR transmitter and receiver; and

a dual-mode wireless telephone, including an IR interface device, which communicates with the base station IR transmitter and receiver, and a RF interface device, which communicates with a cellular communications network.

Preferably, the IR transmitter and receiver respectively include an omni-directional transmitter and an omni-directional receiver.

Preferably, the telephone communicates with the at least one base station substantially exclusively when the telephone is in a vicinity of the base station, wherein the RF interface is substantially deactivated while the telephone is in communication with the base station.

Further preferably, the switchboard communicates with a public telephone network and routes calls to and from the public telephone network through the at least one base station to the telephone. Preferably, the network includes a cellular node coupled to the switchboard, which communicates with the cellular communications network to route cellular calls for the telephone through the local telephone network.

There is also provided, in accordance with a preferred embodiment of the present invention, a method for controlling communications of a wireless telephone having both IR and RF interfaces, including:

communicating using the telephone over the RF interface with a cellular communications network;

sensing the IR signals transmitted by a local telephone network, using the telephone's IR interface; and

transferring the communications of the telephone from the RF interface to the IR interface.

Preferably, sensing the IR signals includes sensing omni-directional IR signals.

Further preferably, transferring the communications includes communicating via the IR interface with the local network, wherein communicating with the local network includes routing cellular calls through the local network.

The present invention will be more fully understood from the following detailed description of the preferred embodiments thereof, taken together with the drawings in which:

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic illustration showing a local telephone network, in accordance with a preferred embodiment of the present invention; and

Fig. 2 is a schematic illustration showing a dual-mode telephone for use in the network of Fig. 1, in accordance with a preferred embodiment of the present invention.

## DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Reference is now made to Figs. 1 and 2, which schematically illustrate a multi-mode local telephone network 10 and a dual-mode wireless telephone 20 for use in the network, in accordance with a preferred embodiment of the present invention. Telephone 20 is shown in Fig. 1 inside a building 24, in which network 10 is wired.

Telephone 20 includes both an antenna 22, with a suitable RF radio unit 30, for communicating with a cellular telephone network outside building 24, and an IR interface device 26, for communicating with IR transmitter/receiver base stations 28 inside the building. IR interface device 26 and base station 28 comprise omni-directional IR transmitters, such as LEDs, and receivers, such as photodiodes. The LEDs and photodiodes preferably have optics coupled thereto suitable for achieving omni-directional transmission and reception, as described, for example, in US Patent Application 08/992,934, which is assigned to the assignee of the present patent application and incorporated herein by reference. Thus, as long as telephone 20 is within a certain radius of base station 28, preferably about 8 m, and the telephone's IR interface device 26 is not completely obscured, communications between the telephone and the station will be maintained. It is not necessary that device 26 be pointed toward station 28 or that there even be a clear line of sight between them, since the IR receivers will also receive radiation reflected from interior walls of the building.

Local network 10 comprises a switchboard 12 which automatically detects when telephone 20 enters building 24 and which registers the location of the telephone in the building as a user of the telephone carries it from room to room. Preferably, switchboard 12 detects and registers telephone 20 by IR communication with interface device 26, even when the telephone is in an idle mode (i.e., not engaged in a call). Switchboard 12 associates telephone 20 with a predetermined telephone extension

number, which is preferably permanently assigned to the user. Thus, when another user inside building 24 dials the extension of the user of telephone 20, switchboard 10 automatically routes the call via base station 28 to telephone 20. Calls from a public switched telephone network (PSTN) 14 for the user of telephone 20 are also routed by the switchboard to the appropriate base station. The user may similarly make outgoing calls to other extensions served by switchboard 12 and to telephones outside building 24 through PSTN 14 via base station 28 and switchboard 12.

Switchboard 12 also communicates with a dedicated cellular node 16, which notifies the cellular network that telephone 20 is within the ambit of the node. The cellular node may communicate with the cellular network either via a radio interface, preferably on normal cellular transmission frequencies, or via a special cable interface. Telephone 20 is assigned an ordinary subscriber telephone number in the cellular network, and can make and receive cellular calls using the number when the telephone is outside building 24. Inside the building, however, incoming cellular calls for the user of telephone 20 are preferably routed by the cellular network automatically to node 16, and from there via switchboard 12 to the telephone. Telephone 20 is generally prevented by switchboard 12 from making outgoing cellular calls while inside building 24, because of the high cost of such calls, and the outgoing calls are automatically routed to PSTN 14. The routing of both incoming and outgoing calls is preferably transparent both to the user of telephone 20 and to the party at the other end of the call.

Optionally, when telephone 20 is outside building 24, or is for some other reason out of contact with base stations 28 in the building, switchboard 12 automatically routes calls for the telephone to the telephone number in the cellular network, preferably via cellular node 16. Thus, whenever the extension of the user of telephone 20 is dialed, switchboard 12 forwards the call to the telephone, through either its RF or IR interface.

The use of network 10 and telephone 20 has several important advantages for the operator of the network (generally a business or other enterprise occupying building 24) and the telephone user. For the operator, the network saves on cellular communications costs, reduces the probability that communications will be intercepted by other parties, and enables telephone users, generally employees of the operator, to

be reached conveniently wherever they are by dialing a single number. For the user, telephone 20 reduces exposure to RF radiation from the telephone, which is believed to have adverse health effects, and provides improved reception, with generally higher bandwidth and reduced interference, when the user is within the building.

Referring now to Fig. 2, it will be observed that telephone 20 includes both RF radio unit 30, coupled to antenna 22, and an IR interface driver 32, coupled to IR interface device 26. Radio unit 30 and driver 32 are coupled via a selector 34 to user input/output equipment 36 (including microphone, speaker, keypad and display) and to other elements of the telephone, which are well known in the art and omitted from the figure for simplicity. When telephone 20 is outside building 24 or otherwise out of communication with base stations 28 in the building, selector 34 defaults to RF operation, and the telephone functions as though it were a conventional cellular telephone. Inside the building, however, selector 34 selects IR driver 32, and the RF radio unit is shut off.

Preferably, in order to determine when to switch over to IR operation, IR driver 32 remains active in a standby mode, even when telephone 20 is idle or is communicating using the RF unit. When the telephone enters building 24, IR interface device 26 begins to receive coded signals from base station 28. IR driver 32 (or alternatively, logic circuits or a processor coupled thereto) analyzes these signals and recognizes the code. Telephone 20 responds to the signals by transmitting an acknowledgment message via interface device 26 and base station 28 to switchboard 12. The switchboard registers the location of the telephone, and calls to and from the telephone are thereafter routed through network 10, as described hereinabove, for as long as IR communications are maintained.

In addition to their functions in communicating with network 10, IR interface device 26 and driver 32 may also be used to communicate with other types of IR-enabled equipment, for example, a portable or desktop computer, Web-enabled television or Personal Digital Assistant. In this way, by addition of suitable software to telephone 20, its IR capabilities can serve for data input and output, as well. Similarly, the IR capabilities can enable the telephone to be used for Internet Web browsing, without going through the cellular network.

It will be appreciated that the preferred embodiments described above are cited by way of example, and the full scope of the invention is limited only by the claims.

WE CLAIM:

1. A dual-mode wireless telephone, comprising:

a RF interface, which communicates with a cellular communications network; and

an IR interface, which communicates with a local telephone network.

2. A telephone according to claim 1, wherein the IR interface comprises an omni-directional interface.

3. A telephone according to claim 1, and comprising a selector, which selects either the RF or the IR interface to be operational for conveying a telephone call between the interface and the respective network.

4. A telephone according to claim 3, wherein the IR interface detects an IR signal transmitted by an IR base station associated with the local telephone network, and wherein the selector selects the IR interface responsive to the signal.

5. A telephone according to claim 4, wherein the selector selects the RF interface when the IR signal is not detected.

6. A telephone according to claim 4, wherein the IR interface detects the IR signal while the RF interface is selected.

7. A local telephone network, comprising:

a switchboard;

at least one base station coupled to the switchboard and comprising an IR transmitter and receiver; and

a dual-mode wireless telephone, comprising an IR interface device, which communicates with the base station IR transmitter and receiver, and a RF interface device, which communicates with a cellular communications network.

8. A network according to claim 7, wherein the IR transmitter and receiver respectively comprise an omni-directional transmitter and an omni-directional receiver.

9. A network according to claim 7, wherein the telephone communicates with the at least one base station substantially exclusively when the telephone is in a vicinity of the base station.

10. A network according to claim 9, wherein the RF interface is substantially deactivated while the telephone is in communication with the base station.

11. A network according to claim 7, wherein the switchboard communicates with a public telephone network and routes calls to and from the public telephone network through the at least one base station to the telephone.

12. A network according to claim 7, and comprising a cellular node coupled to the switchboard, which communicates with the cellular communications network to route cellular calls for the telephone through the local telephone network.

13. A method for controlling communications of a wireless telephone having both IR and RF interfaces, comprising:

communicating using the telephone over the RF interface with a cellular communications network;

sensing the IR signals transmitted by a local telephone network, using the telephone's IR interface; and

transferring the communications of the telephone from the RF interface to the IR interface.

14. A method according to claim 13, wherein sensing the IR signals comprises sensing omni-directional IR signals.

15. A method according to claim 13, wherein transferring the communications comprises communicating via the IR interface with the local network.

16. A method according to claim 15, wherein communicating with the local network comprises routing cellular calls through the local network.

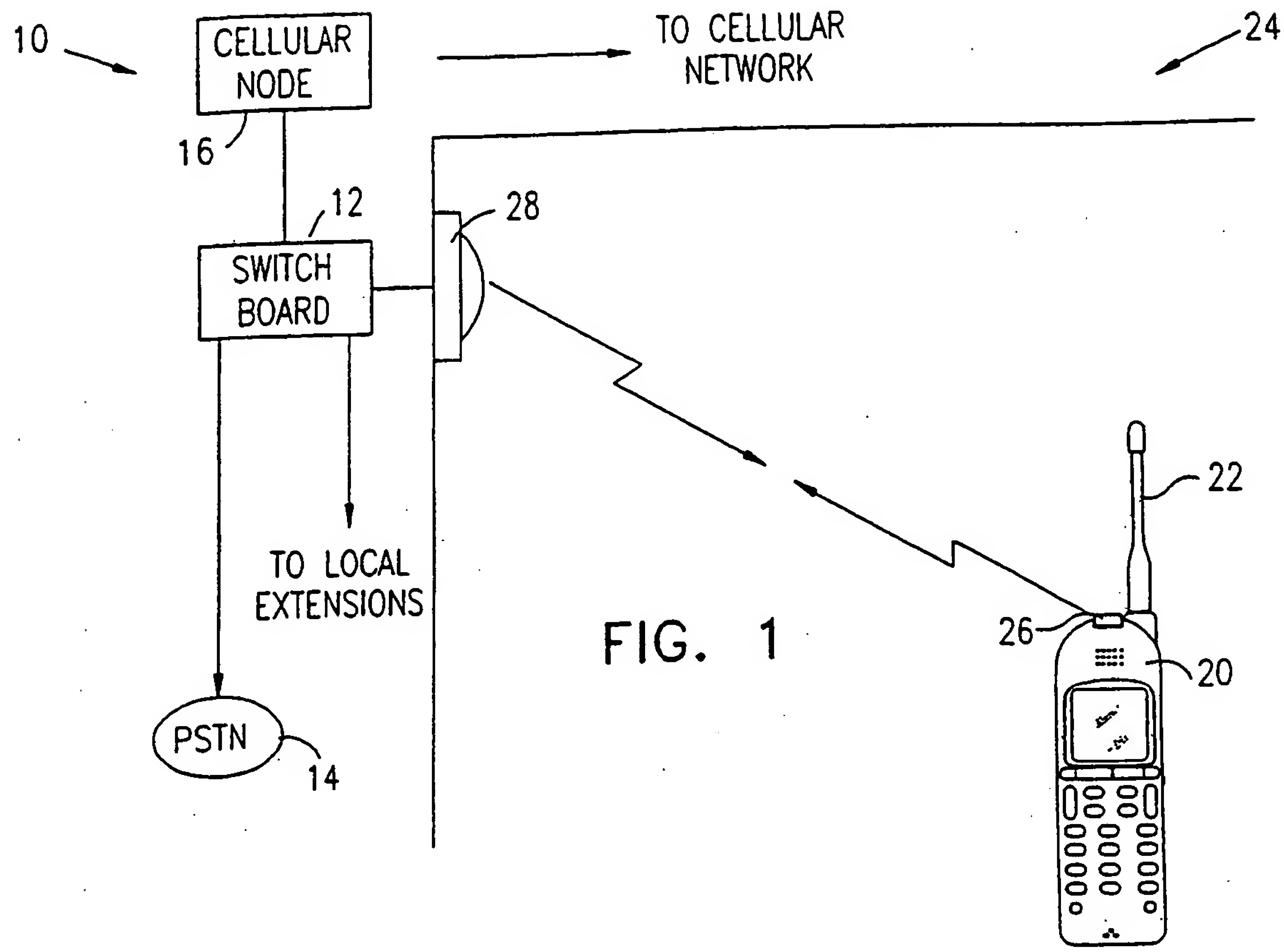
10
CELLULAR NODE
16
TO CELLULAR NETWORK
24
12
SWITCH BOARD
28
TO LOCAL EXTENSIONS
PSTN
14
22
26
20

FIG. 1

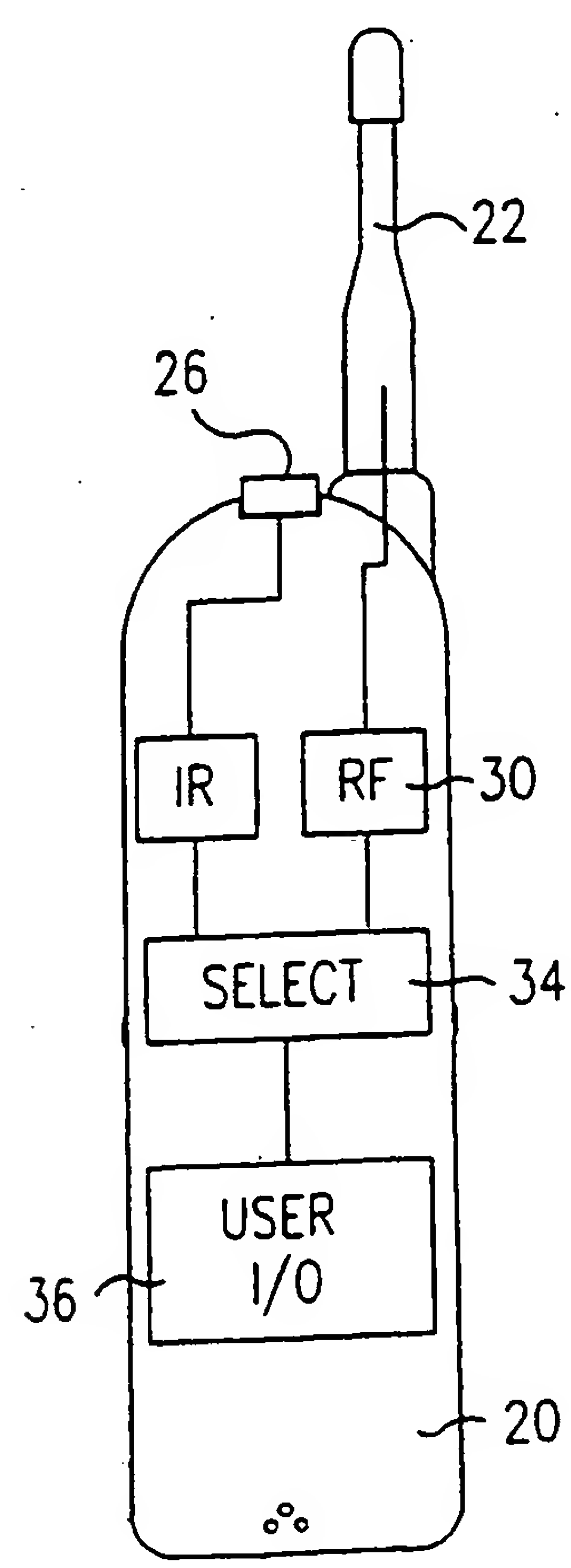
22
26
IR
RF
30
SELECT
34
USER I/O
36
20

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL99/00389

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :H04Q 7/20
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>—<br>Y | US 5,241,410 A (STRECK et al) 31 August 1993, see entire document. | 1, 3-7, 9, 13 and 15.<br>—<br>2, 8, 10-12 14, 16. |
| Y | US 5,566,022 A (SEGEV) 15 October 1996, abstract; col. 2, lines 57-65; fig. 1. | 2,8,14. |
| Y | US 5,535,432 A (DENT) 09 July 1996, col. 3, lines 49-55. | 10 |
| Y | US 5,659,598 A (BYRNE et al) 19 August 1997, fig. 1, col. 4, lines 17-35. | 11, 12, 16. |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of mailing of the international search report

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## INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL99/00389

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

379/56.1, 56.2, 56.3; 455/90, 38.3, 343, 422, 432, 435, 436, 552, 553, 556, 574, 575; 370/310, 338; 359/145, 172; 340/825.71, 825.72

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

379/56.1, 56.2, 56.3; 455/90, 38.3, 343, 422, 432, 435, 436, 552, 553, 556, 574, 575; 370/310, 338; 359/145, 172; 340/825.71, 825.72